

# **Annotated Bibliography of Projects Associated with Reef Fishes in water of Puerto Rico (1998-2014)**

Final Report

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## **Introduction**

The following report is an annotated bibliography of scientific publications, university publications, technical reports, conference proceedings, and gray literature related to studies and observations of abundance and species composition of reef fish communities around Puerto Rico. When available, the annotated bibliography also provides a location of where the reference can be obtained. The references are organized by general geographic location.

## **Annotated Bibliography**

### **Search:**

- **Reef fish in Puerto Rico platform**

### **Keywords:**

- **Reef fish**

### **Time span:**

- **Documents NOAA office (1998- 2001) 14**
  - **DNER (1992) 1**
- **UPRM Marine Sciences Library (2014- 2004) 8**
- **ProQuest Dissertations & theses database- UPR Mayagüez (2013-2009) 8**
- **ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez (2009-2008) 5**
- **Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez (2014-2011) 7**

**Results: 43**

**Searched by: Ivelitza Alcover-Serrano**

### **Areas:**

- **North Puerto Rico**
- **East Puerto Rico:**
  - **Priority area ( Culebra, North East Reserve)**
  - **Other**
- **South Puerto Rico:**
  - **Priority area ( La Parguera, Guayanilla)**
  - **Other**
- **West Puerto Rico:**

- Priority area (Cabo Rojo)
- Other
- Puerto Rico
- Marine Reserve

### North Puerto Rico

**1. Brandon Merten, W. (2014). Dolphinfish Horizontal and Vertical Movements and Population Structure in the Western Central Atlantic. University of Puerto Rico Mayagüez Campus.**

- The main objectives in each chapter were: (i) to examine dolphinfish movement rates relative to differences in coastal geomorphology, bathymetry, and the presence/absence of *Sargassum* spp., (ii) to present a movement model for dolphinfish based on intra and inter-regional movements within the western central Atlantic, (iii) to determine the periodicity of dolphinfish vertical movements, and (iv) to test the genetic structure of dolphinfish within the western central Atlantic relative to Puerto Rico.
- Keywords: dolphinfish, *Coryphaena hippurus*, Western Central Atlantic,
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

### East Puerto Rico

❖ **Priority Area (Culebra, Northeast Reserve)**

**2. Beltran-Rodriguez, D.M. (2008). Spatio-temporal variation in organic nitrogen and carbon in sediments associated with tropical submerged-cage aquaculture. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing. 1451271.**

- The purpose of this study was to evaluate the concentrations of total organic nitrogen (TON), total carbon (TC), and organic matter (OM) in marine sediments near the mariculture site in the south of the Puerto Rican Island of Culebra to determine the spatial and temporal dynamics of these nutrients during the first culture period. At bimonthly intervals, each duplicate benthic sample for chemical analysis was taken

with a PVC core sampler at each of the 15 sampling stations, plus at the control site. The content of organic matter in the sediments was estimated by using the gravimetric method. Results indicate significant differences in the concentration of TON between the cage and control sites. The *L. analis* cage had a higher mean concentration of TON than the *R. canadum* cage and control site. TC and OM mean concentrations were not significantly different. Although the increase of the nutrient concentration is relatively low compared with other studies, data represent only the first year of mariculture activity.

- Keywords: cage aquaculture, *Rachycentron Canadum*, *Lutjanus analis*, aquaculture off-shore, nitrogen, marine sediments, Culebra, Puerto Rico.
- Reference: ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez

### South Puerto Rico

#### ❖ Priority Area (Guánica: Parguera, Guayanilla)

- La Parguera

#### 3. Bejarano-Rodriguez, I. (2013) Deep fish fishes off La Parguera insular slope, Puerto Rico, and their connectivity with shallow reefs. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing, 2013. 3600067.

- This dissertation characterizes the fish community associated with Mesophotic Coral Ecosystems (MCEs) of the La Parguera shelf-slope between 2007 and 2011 using rebreather trimix technical diving. This study represents the first quantitative in situ descriptions of fishes inhabiting MCEs at depths of 50-70 m in Puerto Rico and highlights the role of MCEs as valuable habitats for reef fishes. This study examined the connectivity between shallow and mesophotic depths as expressed by the distribution and movement of fishes, and explicitly tested if MCEs represent an additional habitat and potential refuge for shallow reef fishes, particularly for commercially targeted species.
- Keywords: shallow reefs, deep reef fishes, fish connectivity, mesophotic coral ecosystems (MCE), Puerto Rico
- Reference: ProQuest Dissertations & Theses Global

#### 4. Breadley, P., Santavy, D. L., Gerritsen, J. (2014). Workshop on Biological Integrity of Coral Reefs, August 21-22, 2012, Caribbean Coral Reef Institute, Isla Magueyes,

**La Parguera, Puerto Rico. US Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division, Narragansett, RI. EPA/600/R-13/350.**

- The goals of this workshop were to (1) Identify key qualitative and quantitative ecological characteristics that determine the condition of linear coral reefs inhabiting shallow waters in southwestern Puerto Rico. (2) Use those reef attributes to recommend categorical condition rankings for establishing a biological condition gradient. (3) Ascertain through expert consensus those reef attributes that characterize biological integrity for coral reefs. (4) Develop a conceptual, narrative model that describes how biological attributes of coral reefs change along a gradient of increasing anthropogenic stress. In the appendix I section it provides abundance of the fishes found on the different stations.
- Keywords: quantitative, coral reef, fish communities, shallow water, Puerto Rico, La Parguera
- Reference: Marine Sciences Library- University of Puerto Rico in Mayaguez

**5. Caraballo Marrero, A. N. (2010) Taxonomic composition and abundance of demersal zooplankton associated to seagrass and sandy substrates of a coral reef environment. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 1481882.**

- The purpose of this study was to examine the influence of different benthic habitats in the taxonomic composition and abundance of demersal zooplankton in coral reef systems of La Parguera. Two techniques were used to sample zooplankton abundance; horizontal plankton tows between surface and near bottom and demersal traps for substrate sampling. Chapter I states that extensive sea grass beds are well established in La Parguera, and *Thalassia testudinum* and *Syringodium filiforme* are the most common and widely distributed species. In this study it was found that fish larvae remained very close to the bottom of *Thalassia* beds during daytime, a factor that contributed for that is that most of the *Gobiidae* fish larvae are found on sand or mud bottoms. The *Gobiidae* were most abundant among of fish larvae collected by near bottom samples. The *Clupeiformes* larvae were the most abundant fish larvae in surface samples.
- **Note:** the thesis was added to this annotated bibliography because of the information it contains about *Gobiidae* fish.
- Keywords: *Thalassia* beds, zooplankton, seagrass, La Parguera, coral reef, fish, *Gobiidae*, fish larvae
- Reference: ProQuest Dissertations & Theses Global

- 6. García- Sais, J. (1994) La Parguera marine fishery reserve: a feasibility study. Department of Marine Sciences, University of Puerto Rico- Isla Magueyes laboratory.**
  - This is the first annual report of a two year feasibility study for the establishment of a Marine Fishery Reserve (MFR) in La Parguera. The project represents a joint effort by local fishermen, scientists, and regulatory agencies towards the conservation and improvement of coral reef fishery resources. The island reefs studied were Turrumote, Media Luna and San Cristobal. Scientific studies in this report include a basic assessment of relative abundance and size distributions of commercially important fish population at the three reef site alternatives and larvae fish distributions.
  - Keywords: reef fish surveys, larval fish distributions, Marine Fishery Reserve, feasibility study
  - Reference: Copy at NOAA Fisheries Caribbean Field Office
  
- 7. Hill, R., Garcia- Sais, J. (1994) Techniques and assessments of baseline conditions for identifying changes associated with the Marine Fishery Reserve in La Parguera, Puerto Rico. Proceedings of the 47<sup>th</sup> Gulf and Caribbean Fisheries Institute annual meeting. Margarita Island, Venezuela.**
  - In anticipation of the establishment of the Marine Fishery Reserve at La Parguera on the southwestern coast of Puerto Rico, a two year feasibility study was initiated to allow the detection of community level changes in the surrounding reef areas. Commercially important fishery species on the three potential reserve sites were targeted for underwater visual census using a time-based “Active Search Census” method. Preliminary data show significant differences in the dominant family groups and in the most abundant species between the three reef study sites.
  - Keywords: visual census, marine reserve, active search census, fishes
  - Reference: Copy at NOAA Fisheries Caribbean Field Office
  
- 8. Merten, W. B. (2009). Acoustically monitoring coral reef fishes to determine short-term spatial and temporal movement and habitat utilization patterns. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing. 1468676.**

- The spatial and temporal movement and habitat utilization patterns of coral reef fishes were quantified using acoustic telemetry on 16 coral reef fish taken from 9 species across 5 families. Fish were caught in traps and surgically implanted with coded-acoustic transmitters and released back into the water by divers. The study site in La Parguera, Puerto Rico included 12 acoustic receivers set in an array from nearshore mangrove habitats to midshelf fringing reef zones. Samples were monitored from 1 to 63 days with total detections ranging from 1 to 43,182. Only two fish, both *Ocyurus chrysurus*, were recorded to have moved outside of the release site to contiguous receivers. Temporal movement patterns were observed to vary among species. The temporal pattern of recordings suggest that some species were engaging in crepuscular and nighttime feeding while others were seeking shelter during the same period.
- Keywords: reef fish, acoustic telemetry, La Parguera, Puerto Rico, movement patterns
- Reference: ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez

**9. Pittman, S. J., Hile, S. D., Jeffrey, C. FG., Clark, R., Woody, K., Herlach, B. D., Cladow, C., Monaco, M. E., Appeldoorn, R. (2010). Coral reef ecosystems of Reserva Natural de La Parquera (Puerto Rico) : spatial and temporal patterns in fish and benthic communities (2001-2007). NOAA Technical Memorandum NOS NCCOS 107.**

- The report provides a spatial and temporal characterization of the fish and benthic communities of southwestern Puerto Rico, primarily within the La Parguera Natural Reserve. The data and synthesis in this report are intended to provide essential baseline biological information to support future management decision making. The project is a component of NOAA's Caribbean Coral Reef Ecosystem Monitoring (CREM). Chapter 3 focuses on the fish communities, groups and species.
- Keywords: quantitative, fish communities, La Parguera, Puerto Rico, coral reef ecosystem
- Reference: Marine Sciences Library- University of Puerto Rico in Mayaguez

**10. Rivera Betancourt, G. A. (2010). Population dynamics and resource utilization by the dusky damselfish, *Stegastes adustus*. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 3401408.**

- Coral reef fishes depend upon the reef substrate for the duration of their lives. The spatial and temporal abundance variability of the Caribbean dusky damselfish, *Stegastes adustus* was studied in the coral reef ecosystem of La Parguera, southwestern Puerto Rico and evaluate if its abundance and spatial distribution are related to microhabitat characteristics that could regulate populations. This study suggests that *S. adustus* is an opportunistic generalist that settles and recruits to a specific habitat but that juveniles and adults may further benefit from modifying their surroundings. This is the first study involving observational and experimental methods with any *Stegastes* species in Puerto Rico in approximately 25 years.
- Keywords: coral reef fishes, *Stegastes adustus*, damselfish, La Parguera, *Montastrea annularis*
- Reference: ProQuest Dissertations & Theses Global

**11. Rodriguez- Santiago, A. E. (2009). Mitochondrial DNA analyses for species identification of snappers from Caribbean waters. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 3327352.**

- This study examined phylogenetic relationships among fifteen species of the *Lutjanidae* family occurring within the Caribbean Basin, based on mitochondrial 12S rDNA analysis. This is the first phylogenetic study that includes all 3 subfamilies of lutjanids occurring in the Caribbean. Diagnostic polymorphisms within the mitochondrial DNA (mtDNA) for 15 lutjanid species in the Caribbean were identified. Specimens were obtained from local catches at La Parguera, Puerto Real and Rincón, western Puerto Rico and Cataño, at the north.
- Keywords: mitochondrial DNA, snappers, Caribbean, *Lutjanidae*, marine protected areas
- Reference: ProQuest Dissertations & Theses Global

**12. Ruiz Torres, H. J. (2012). Spatial and temporal variations in the relative abundances of coral reef algae in southwest Puerto Rico. University of Puerto Rico, Mayagüez campus.**

- A detailed 5 year study of algal community structure at 8 coral reefs distributed across the insular shelf at La Parguera, Puerto Rico was undertaken between 2003 and 2007. Significant temporal variation in species cover and composition was documented for the shelf edge reefs. Conversely little temporal variation at mid shelf or inshore reefs occurred during the same time period. Previously considered as being

a relatively undisturbed ecosystem, the shelf edge reefs in the southwest Puerto Rico were documented to be undergoing a phase shift from a coral dominated reef to an algal dominated reef. The significant and dramatic increase in total cover of shelf edge benthic algae was calculated to be 43%. It correlates overfishing of parrotfish (*Scaridae*) and surgeonfish (*Acanthuridae*) plus increase in nutrient concentrations, have favored macroalgae.

- Keywords: coralline algae, La Parguera, herbivore consumption, coral reef, macroalgae
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

**13. Schärer-Umpirre, M. T. (2010). Using landscape ecology to describe habitat connectivity for coral reef fishes. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 3401411.**

- Landscape composition and habitat configuration were tested to explain the presence and abundance of ontogenetic stages of reef fishes. When compared to La Parguera (with abundant mangroves and seagrass), the presence and abundance of some species at Mona were limited. It was determined which reef fishes conduct ontogenetic habitat shifts at Mona Island and identified their nursery habitats. The distribution, size and abundance of coral reef fishes were used to determine habitat use during three main life stages (early juvenile, juvenile and adult). This study relates habitat characteristics and landscape ecology metrics with five reef fishes shown to conduct ontogenetic migrations. The presence and abundance of three grunts and two snappers were correlated with habitat and landscape attributes in order to determine which features influenced distribution and abundance of the distinct ontogenetic life stages for each species. Fish size data were correlated with depth to identify species with ontogenetic cross-shelf migrations.
- Keywords: nursery habitats, Mona island, Puerto Rico, ontogenic stage, reef fishes, La Parguera, landscape ecology, grunt, snapper, habitat connectivity
- Reference: ProQuest Dissertations & Theses Global

**14. Tzadik, O. (2010) Habitat characteristics as determinants of shelf edge fish communities, with emphasis on Scarid populations, off La Parguera, P.R. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 1487573.**

- In order to investigate the relationship between habitat complexity and fish utilization, this study has concentrated on the factors affecting Scaridae abundance at the shelf edge off of La Parguera, Puerto Rico. For remotely sensed data sets as well as in situ measurements, rugosity was classified using new techniques, developed for this study, that minimize bias associated with the slope of the substratum. An empirical orthogonal function analysis showed that parrotfish abundance on the shelf was associated primarily with structural variables. The results obtained from this study provide a novel approach to data interpretation that can be used in determining critical habitat to sensitive fish species.
- Keywords: shelf edge reefs, fish habitat, *Scaridae*, Puerto Rico, La Parguera, parrotfish
- Reference: ProQuest Dissertations & Theses Global

- **Guayanilla**

**15. Center for energy and environment research with the collaboration of The Institute of Chemical Engineers, Colegio de Ingenieros y Agrimensores de Puerto Rico. Mayaguez, Puerto Rico. 32-45p. 83-89p.**

- The study described in pages 32-45, was an attempt to evaluate a fish community response to a thermally enriched tropical bay, which receives hot water discharges from a 1,105 MW power plant in Puerto Rico. Monthly gill net samples were taken at similar habitats in and near a thermally enriched portion of eastern Guayanilla Bay. The Shannon-weaver species diversity index and the Sorenson similarity index were calculated to aid in describing fish distribution with respects to high temperatures. In pages 83-89, concerned by the over contamination of the marine environment with mercury an analysis was conducted to quantify the concentration of it in fish near de bay. Primarily because the bioaccumulation of this element in fish pose a potential hazard to human consumers. The data presents a list of species found on the Guayanilla bay and the percentage of mercury found.
- Keywords: thermal, bay, temporal distribution, diet
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**16. Lopez, J. M. (Editor/Organizer) (1979). Proceedings of the symposium on energy industry and the marine environment in Guayanilla bay. Lecture conducted from Center for energy and environment research with the collaboration of The institute of**

**chemical engineers, Colegio de ingenieros y agrimensores de Puerto Rico. Mayaguez, Puerto Rico. 32-45p. 83-89p.**

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- Keywords: thermal, bay, temporal distribution, diet
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**17. University of Puerto Rico. Puerto Rico nuclear center: Guayanilla bay environmental report 1971-1974. For U.S. Energy and research development administration. 72-76 p. 116-124p.**

- The main objectives of the study was to obtain baseline data applicable to thermal tolerance studies in Jobos Bay. Guayanilla Bay is a small, shallow embayment approximately four miles long and two miles wide that is fifty miles west of Jobos Bay. In Guayanilla the effects of high temperatures on zooplankton, benthic organisms, mangrove root communities, algae, and fish were investigated. The tables in pages 72-76 provide information about the fishes taken in Guayanilla bay up to January 1973 compared to those on Jobos bay and where they were taken. The figures in pages 116-124 represent the food webs constructed from fish data in Guayanilla Bay, 1971-1972.
- Keywords: bay, reef area, thermal, food webs
- Reference: Copy at NOAA Fisheries Caribbean Field Office

❖ **Other**

**18. Berrios-Díaz, J.M., González-Azar, J.K., Díaz-Rodríguez, I. (1986). Fish population studies of the sea grass beds and coral reefs of Cayo Berberia and Cayo Ratonés. Department of Natural Resources.**

- Two coral reefs in the south coast of Puerto Rico (Cayo Berberia and Cayo Ratones) were visually censused between 1983 and 1985 to determine the effects of sedimentation on their sport fish populations. Species composition, species diversity, dominant species and abundance were the parameters compared within and between the zones of the two reefs studied. The objective of this study was to determine the density of the principal sport fishes in the two reef areas and to assess the impact of sedimentation stress on coral reef communities and their fish population by comparing healthy and stressed sites.
- Keywords: coral reefs, sport fish population, sedimentation, census
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**19. Aguilar-Perera, J.A. 2004. Coastal habitat connectivity of reef fishes from southwestern Puerto Rico. University of Puerto Rico Mayaguez campus. A dissertation submitted in partial fulfillment of requirements for the degree of Doctor in Philosophy in marine sciences (Thesis).**

- Based on underwater visual censuses, the present study determined the pattern and extent of habitat use in post-settlement fishes and how these processes may change during ontogeny, leading to a quantification of habitat connectivity. The study was divided in three components: (1) presenting a baseline characterization of the fish community structure along an inshore-offshore, cross-shelf gradient from Montalva Bay to Turrumote, (2) evaluating the nursery value of these habitats, and (3) providing evidence for ontogenic migrations and habitat shifts. There were significant differences in community structure and spatial distribution of fishes among these habitats, revealing an unequal spatial pattern. Among the dominant groups were *Haemulidae*, *Pomacentridae*, *Scaridae*, *Labridae*, *Lutjanidae* and *Acanthuridae*.
- Table of density of fishes in the different areas pages 35- 44
- Keywords: Montalva Bay, Turrumote, Southwestern, fish community structure, Romero key, coral, nursery, juveniles
- Reference: Marine sciences library

**West Puerto Rico**

❖ **Priority Area – Cabo Rojo**

**20. Figuerola Fernández, M., Torres Ruiz, W. (2000). Reproducción en el mero mantequilla (*Cephalopholis fulva*) y evaluación preliminar de la veda durante las agregaciones de desove del mero cabrilla (*Epinephelus guttatus*) en el oeste de Puerto Rico.**

**Departamento de Recursos Naturales y Ambientales. Negociado de pesca y vida silvestre- Laboratorio de Investigaciones Pesqueras.**

- The aim of this study was to determine several reproductive parameters of the coney (*Cephalopholis fulva*), and to evaluate the seasonal closure for red hind (*Epinephelus guttatus*) established in 1996 at the spawning aggregation sites known as El Bajo de Cico and Abrir La Sierra. From November 1997 to March 1999 a total of 1,173 red hinds and 987 coneys were sampled off the West Coast of Puerto Rico. A subsample of 596 coneys and 708 red hinds were examined histologically. The presence of transitional individuals, as well as significant size differences between males and females, confirm protogynous hermaphroditism in *C. fulva*.
- Keywords: *Epinephelus guttatus*, *Cephalopholis fulva*, reproduction parameters, agregation site, fish spawning, protogynous hermaphroditism, red hind seasonal closure, Abrir La Sierra, Bajo de Cico, Tourmaline
- Reference: Copy at NOAA Fisheries Caribbean Field Office
- Note: Report is in Spanish

**21. Marshak, A. R. (2008). Evaluation of seasonal closures of red hind, *Epinephelus guttatus* (Pisces: Serranidae), spawning aggregations to fishing off the west coast of Puerto Rico, using fishery-dependent and independent time series data. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing. 1451336.**

- The red hind (*Epinephelus guttatus*) is one of Puerto Rico's most important commercial and recreational fishes. Following stock decline, an annual spawning season fishing closure was enacted in 1996 for three aggregation sites off the west coast. Although presently continuing, its effectiveness toward population recovery has not been fully assessed. SEAMAP-C fishery-independent red hind data (Apr 1988-Mar 2006), and fishery-dependent reported landings and port-sampled biostatistical data, from the western platform of Puerto Rico were analyzed to infer recovery. An initial post-enactment increase of fishery-independent Catch-per-Unit-Effort (CPUE; kg/trip) was observed throughout the platform, and within spawning aggregations. Although the closure was initially effective in stemming further stock decline, shifts in fishing strategy overrode potential recovery of red hind.
- Keywords: red hind, *Epinephelus guttatus*, commercial and recreational fishes, Tourmaline, Abrir La Sierra, Bajo de Sico

- Reference: ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez

**22. Rowell, T. J.(2012). Passive Acoustics as an indicator of red hind, *Epinephelus guttatus*, density at a spawning aggregation. University of Puerto Rico, Mayagüez campus.**

- The following manuscript details the methods, findings, and implications of an intensive study conducted during 2010-2011 at a red hind, *Epinephelus guttatus*, spawning aggregation site, in which the relationship between red hind sound production and aggregation density was examined. This accumulation of work was based off of a pilot study conducted during January-February 2010. The manuscript has been submitted for publication in the Marine Ecological Progress Series, and is formatted accordingly.
- Keywords: *Epinephelus guttatus*, passive acoustics, Abrir la Sierra, Puerto Rico, reproduction, behavior
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

❖ **Other**

**23. Esteves-Amador, R. (2013). Short-term changes to the coral reef fish community structure following the regional coral bleaching event of 2005. University of Puerto Rico, Mayagüez Campus.**

- This study determines the extent of how reef fish communities reacted to the regional disturbance of coral bleaching in 2005, based on annual visual surveys along permanent belt-transects on two oceanic and three neritic reef sites along the west and south coast of Puerto Rico between 1999 and 2011. The study was divided in three components: (1) providing an “a-posteriori” analysis of distance from shore, rugosity, live coral, algae and depth as sources of variability of dissimilarity between the multispecies fish assemblages prior to the 2005 bleaching event, (2) identify changes of reef fish community structure on individual reef as measured by the variations of species diversity, abundance and taxonomic composition before and after the 2005 coral bleaching event, and (3), evaluating the implications of apparent losses in live coral cover.
- Keywords: coral reef, fish community, coral bleaching, Puerto Rico, quantitative
- Reference: Marine Sciences library- University of Puerto Rico in Mayaguez

**24. Garcia-Sais, J. 2010. Reef habitats and associated sessile-benthic and fish assemblages across a euphotic-mesophotic depth gradient in Isla Desecheo, Puerto Rico. 29:277-288 University of Puerto Rico in Mayaguez.**

- Quantitative surveys of sessile benthos and fish populations associated with reef habitats across a 15-50m depth gradient were performed by direct diver observations using rebreathers at Isla Desecheo, Puerto Rico. A total of 119 diurnal, non-cryptic fish species were observed across the depth gradient, including 80 species distributed among 7,841 individuals counted within belt transects. Fish species richness was positively correlated with live coral cover.
- Keywords: mesophotic, fishes, corals, Puerto Rico, Isla Desecheo, Caribbean
- Reference: Marine Sciences library

**25. Jimenez-Marrero, N. M. (2010) Fish, algae and coral dynamics from various reefs in southwest Puerto Rico. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing. 3401402.**

- This study was composed of three experiments in 7 reef sites, at 5 and 10m off the southwest coast of Puerto Rico, to examine fish, algae, and coral dynamics. The third experiment consisted of fish surveys conducted at each site and depth contour on three different occasions using the stationary plot technique with discrete group sampling. Fish abundance was positively associated with macroalgae cover. Turbidity and light intensity affected fish density.
- Keywords: Coral reefs, reef fish, algae, cyanol
- Reference: ProQuest Dissertations & Theses Global

**26. Lopez-Ortiz, R. (2009). The diet of masked, brown and red-footed boobies (*Sulidae: Pelecaniformes*) in the Mona Passage, Puerto Rico. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing. 3370070.**

- This study consisted of four visits to Monito Islet in the Isla de Mona Natural Reserve, the prey description (diversity, dominance, importance, length, taxonomy and volume), the dietary niche (breadth, contribution and overlap) and the feeding strategy were studied through regurgitation analysis of three pelagic bird species roosting and nesting in sympatry, and constituting the genus *Sula* in the west Indies. This is the first detailed description of the diet of the genus *Sula* in the Caribbean Sea.

The findings have implications in the use of seabirds as indicators of epipelagic fish stock fluctuations.

- Keywords: *Sulidae*, *Pelecniformes*, epipelagic fish, flying fishes, *Coryphanaea huppurus*, *Decapterus macarellus*, *Parexocoetus hillianus*, *Cypselurus comatus*, Mona island, Monito islet, Puerto Rico.
- Reference: ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez

**27. Rosario, A. (1998). Completion Report 1994-1998: Shallow-water reef fish survey, queen conch survey, spiny lobster larval recruitment survey. Department of Natural and Environmental Resources Research Laboratory.**

- The surveys included in this completion report covered three different sampling projects and methodologies. The first sampling period corresponds to the last sampling cycle of a three-year survey of reef fish resources. During the third and final sampling period of the Shallow water Reef Fish Survey that corresponded to April 1994 to March 1995, a total of 35 stations were sampled west of parallel 67 of Puerto Rico. The two most important commercial groups, snappers and groupers, constituted 77.3% of total catch. It is believed that the obtained species composition reflects the actual landing of commercial fishers in Puerto Rico for the fishing gears used in this survey.
- Keywords: quantitative study, snappers, groupers,
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**28. Rosario-Jiménez, A., Figuerola-Fernández, M. (2001). Tag and recapture study of red hind and coney at three spawning aggregations sites off the west coast of Puerto Rico. Fisheries Research Laboratory/ BFWL/PR-DNER.**

- Pilot study of mark-recapture for red hind (*Epinephelus guttatus*) and coney (*Cephalopholis fulva*) was started at three closed spawning aggregations off the West Coast of Puerto Rico. A total of 374 red hinds and 579 coneys were tagged and released between January and June 1999.
- Keywords: coneys, *Cephalopholis fulva*, red hinds, *Epinephelus guttatus*, tagging, aggregation sites, West Coast, Puerto Rico
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**29. Sadovy, Y., Figuerola, M., Román, A. (1992). Age and growth of red hind *Epinephelus guttatus* in Puerto Rico and St. Thomas. Fishery Bulletin, U.S., 90, pp. 516-528.**

- Red hind taken by fish trap and hook-and-line in western Puerto Rico and the U.S. Virgin Island of St. Thomas were aged using sectioned otoliths (sagittae). Ages were validated by marginal increment analysis for fish ages 1-10 yr, and by a field study involving oxytetracycline injection for fish ages 1-4; a single opaque and translucent zone (viewed under transmitted light) is deposited annually. Sex and stage of sexual maturation were determined for a subsample of aged fish from Puerto Rico. The occurrence of sexually-transitional individuals, as well as significant differences between the sexes in both size and age, confirm protogynous hermaphroditism for fish from Puerto Rico.
- Keywords: red hind, *Epinephelus guttatus*, age and growth, Puerto Rico, St. Thomas, Otolith analysis, sexual maturity, protogynous hermaphroditism
- Reference: Departamento de Recursos Naturales; pdf download at <http://www.drna.gobierno.pr/oficinas/arn/recursosvivos/negociado-de-pesca-y-vida-silvestre/laboratorio-de-investigaciones-pesqueras-1/publicaciones/Age%20-%20growth%20of%20red%20hind%20E.%20guttatus%20in%20PR-ST.pdf>

**30. Williams, S. J. (2011). The movement of White grunts (*Haemulon plumierii*) relative to habitat and boundaries at various spatial and temporal scales. University of Puerto Rico, Mayagüez campus.**

- This study investigates the movements of subadult and adult white grunts (*Haemulon plumierii*) at various scales with respect to habitat, with particular emphasis to boundaries. Acoustic telemetry tested boundary responses through displacement and identified short and long-term movement patterns. Visual surveys at 9 sites, with video recordings at 3 sites were used to characterize behaviors and their relation to the reef-sand interface at dawn, midday and dusk. Using high-resolution bathymetry and a modified benthic habitat map, the spatial patterns of acoustic receiver reception range were examined relative to geomorphology. The study was conducted at inshore and offshore emergent reefs in southwest Puerto Rico. Twelve tagged fish were displaced from point of capture. Most were able to return, even across broad expanses of sand between two emergent reefs.
- Keywords: *Haemulon plumierii*, spatial distributions, acoustic telemetry, Puerto Rico, boundaries

- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

## **Puerto Rico**

### **31. Figuerola Fernández, M., Torres Ruiz, W. (2001). Aspectos de la biología reproductiva de la sama (*Lutjanus analis*) en Puerto Rico y recomendaciones para su manejo. Final report. Departamento de Recursos Naturales y Ambientales. Negociado de pesca y vida silvestre-Laboratorio de Investigaciones Pesqueras.**

- Provides the results of a study on the reproductive biology of the mutton snapper, *Lutjanus analis*, in Puerto Rico between February 2000 and May 2001. From the 390 gonads collected around all Puerto Rico, with the cooperation of commercial fishermen and personal from the Laboratorio de Investigaciones Pesqueras, 359 were examined histologically. The sizes on which 50% of males and females reach their sexual maturity is at 330 and 414 mm FL, respectively. A detailed study of the gonads reveals that the spawning period is limited to 6-7 days after the full moon in April and May. This is the first local study of the mutton snapper reproduction in Puerto Rico.
- Keywords: mutton snapper, *Lutjanus analis*, Puerto Rico, fish spawning, reproductive biology, aggregation sites
- Reference: Copy at NOAA Fisheries Caribbean Field Office
- **Note:** Report is in Spanish

### **32. García-Moliner Basora, G. E. (2013). Satellite remote sensing characterization of fish spawning aggregation sites in Puerto Rico and the United States Virgin Islands. University of Puerto Rico, Mayagüez campus.**

- This work investigates the seasonality of the satellite-derived chlorophyll signal (Chl-a) at eight established fish spawning aggregation sites in Puerto Rico and the United States Virgin Islands and events that might influence this signal. These fish spawning

aggregation sites are recurrent, meaning that fish (i.e., red hind *Epinephelus guttatus* (Linnaeus) and mutton snapper *Lutjanus analis* (Cuvier)) aggregate at these sites every year, over the same periods of time. This approach can then be applied to describe fish spawning aggregation sites of other species, specifically to understand the reasons why these sites appear to be used sequentially by other species. The information presented here adds one more parameter to the complexities of environmental cues for the success of fish spawning aggregations.

- Keywords: fish spawning, chlorophyll signal, *Epinephelus guttatus*, *Lutjanus analis*, Puerto Rico, U.S. Virgin Islands
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

**33. Mateo, I., Durbin, E., Appeldoorn, A., Adams, A., Juanes, f., Kingsley, R., Swart, P., Durant, D. 2010. Role of mangroves as nurseries for French grunt *Haemulon flavolineatum* and schoolmaster *Lutjanus apodus* assessed by otolith elemental fingerprints. Vol. 402: 197-212. Marine ecology progress series.**

- Juvenile French grunt *Haemulon flavolineatum* and schoolmaster *Lutjanus apodus* were captured in mangrove and seagrass stations in St. Croix, and Puerto Rico in 2006-2007 to determine whether areas for juvenile fish can be discriminated by means of otolith chemistry. This study contains the first direct evidence of post settlement fish movement connecting mangrove habitats to the reef using otolith chemistry.
- Keywords: fish nursery, otolith chemistry, stable isotopes, *Haemulon flavolineatum*, *Lutjanus apodus*, juvenile habitat.
- Reference: Marine Sciences library

**34. Mateo, I., Durbin, E., Appeldoorn, R., Adams, A., Juanes, F., Durant, D. 2011. Inferred growth of juvenile French grunts, *Haemulon flavolineatum*, and schoolmaster, *Lutjanus apodus*, in mangrove and seagrass habitats. 87(3), P. 339-350. Bulletin of marine science. Reprint.**

- Growth, survival and abundance of young, and their connectivity to adult populations are four primary factors used to define nursery habitats. In the study were examined the relative quality of mangrove and seagrass habitats for juvenile French grunt, *Haemulon flavolineatum*, and schoolmaster, *Lutjanus apodus*, reef populations in St. Croix and Puerto Rico by using otolith microstructure to compare growth in these

habitats. Mean daily otolith increment widths during the post-settlement period (30-60 d) of surviving late juvenile French grunts and schoolmaster collected in 2007 were compared between mangrove and seagrass habitats within each island

- Keywords: Nursery, Otolith microstructure, French grunt, school master, mangrove habitats, *Lutjanus*
- Reference: Marine Sciences library

**35. Matos-Caraballo, D. (1996). Status of the groupers in Puerto Rico, 1970-95. Gulf and Caribbean Fisheries Institute 49<sup>th</sup> annual meeting, Barbados.**

- The objective of this paper are to review the landings data collected by FSP, for the groupers from 1971-95 and review the biostatistical data of the most important commercial fishery grouper species collected by FSP. Groupers landings data and length suggest that the status of grouper fishery resources in Puerto Rico were declining.
- Keywords: *Epinephelus*, *Mycteroperca*, groupers, *Serranidae*, statistics
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**36. Medina-Rios, S. (2009). Metazoan parasites of groupers (*Epinephelinae*, Pisces) from Puerto Rico. University of Puerto Rico, Mayaguez (Puerto Rico), ProQuest, UMI Dissertations Publishing, 1468808.**

The subfamily *Epinephelinae* (Groupers) is a major group of commercially important fishes of the world with 19 species reported from Puerto Rico. The goal of the present study was characterize the diversity of parasites that affect groupers in Puerto Rico. A total of 54 species of parasites were found in 116 individual from 16 species of groupers, which represents an increase of 56% in comparison with previous reports. This study reports 27 or 50% new host records. The present study increased the existing knowledge about the diversity of parasites in groupers from Puerto Rico, Caribbean, and the Western Atlantic. Data about the parasites associated with fishes from the Caribbean could allow the eventual mitigation or management of these disease problems damaging valuable fisheries.

- Keywords: *Epinephelinae*, grouper fish, parasites, Puerto Rico.

- Reference: ProQuest Dissertations & Theses @ University of Puerto Rico – Mayaguez

**37. Nemeth Feliciano, M. (2013). Distribution of Roving Herbivorous Fishes on Coral Reefs at Multiple Spatial Scales. University of Puerto Rico, Mayagüez campus.**

- This study examined the ecology of surgeonfish (*Acanthuridae*) and parrotfish (*Scaridae*) in three parts: (1) their distribution on fore-reefs in relation to transect scale characteristics, (2) the spatial pattern in the interaction between fish and algae, and (3) the relative importance of composition and configuration seascape metrics to determine how these help explain spatial patterns at a large scale. A multi-scale seascape approach correlating composition and configuration metrics to 810 random fish surveys confirmed topographic relief as an important factor positively related to herbivorous fish biomass. Overall the results suggest that the distribution of roving herbivorous fishes is influenced by habitat characteristics related to preferred feeding sites that can be described by a combination of in-situ and seascape scale metrics.
- Keywords: surgeonfish, *Acanthuridae*, parrotfish, *Scaridae*, seascape metrics, herbivorous fish, ecology
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>

**38. Ramos-Ascherl, Z. (2013) Parasitism in *Pterois volitans* (*Scorpaenidae*) from coastal waters of Puerto Rico, the Cayman Islands and the Bahamas. University of Puerto Rico, Mayaguez (Puerto Rico). ProQuest, UMI Dissertations Publishing. 1553156.**

- Individuals of *P.volitans* from Puerto Rico, Cayman Islands and Bahamas were examined for parasites. A total of 26 parasitic species were recovered. 2 first fish-association records were reported. Results from samples from Puerto Rico collected between 2009-2012 indicate there was no significant difference between yearly community compositions, although there was an incremental increase of parasitic species with time. Some of the observed species infecting lionfish are known to kill native fish species; however lower prevalences were recorded.
- Keywords: Lionfish, Puerto Rico, Bahamas, Cayman islands, parasites
- Reference: ProQuest Dissertations & Theses Global

**39. Rosario-Jiménez, A. (1988). Monitoring of commercially exploited fisheries resources in Puerto Rico. Corporation for the Development and Administration of the Marine, Lacustrine, and Fluvial Resources.**

- Monitoring program was conducted for two sampling periods, first from April 1986 to March 1987 and second from April 1987 to March 1988 to determine the distribution, relative abundance, and seasonal population fluctuations of commercially exploited fish and spiny lobster resources in selected fishing areas around Puerto Rico. Three coasts were monitored: East, South and West. Two species of groupers (*Serranidae*) constituted the majority of the catch for both sampling periods.
- Keywords: monitoring, commercially exploited fisheries, *Serranidae*, quantitative study, Puerto Rico, *Lutjanidae*, *Haemulidae*
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**40. Vivaldi, J., Berrios-Díaz, J., Corujo-Flores, I., González-Azar, J., & Erdman, D. (1988). Los peces marinos de Puerto Rico. In *Compendio enciclopédico de los recursos naturales de Puerto Rico* (1st ed., Vol. 7). San Juan, Puerto Rico: Editorial Librotex.**

- The information presented in this volume results from the compilation of the works and inedited studies of the species of fish that habit commonly in the water off the coast of Puerto Rico. The purpose of this work is to provide information to fishermen, students, scientists and other citizens interested in fishing and in marine fishes. The families included in this catalog are listed in alphabetic order. It has been used to list genres and species. A description of the family proceeds the catalog of the species commonly found by fishermen. The scientific names follow Robins et al. (1980) and the common names follow Erdman (1974).The discussion of each species includes a re-count of the most important morphologic and ecologic characteristics. To facilitate the identification of some species there are images that highlight the most pronounced characteristics. It also includes information about the sporting importance and the capture.
- Keywords: salt water fish, marine fish, sport fishing
- Reference: Copy at NOAA Fisheries Caribbean Field Office

**41. Rivera Betancourt, G. A. (1994). Age and growth of dolphinfish, *Coryphaena hippurus* L., in Puerto Rico as determined by otolith analysis. University of Puerto Rico, Mayagüez campus.**

- Dolphinfish were sampled over an eight-month period to study age and growth using daily increments recorded in the sagittae. Increments were read on whole otoliths viewed under a compound microscope. A total of 121 otoliths were analyzed from male and female fish sampled from both the north and south coasts. Growth was analyzed with both a linear and von Bertalanffy model. It was observed that growth is rapid and non-linear; growth followed the von Bertalanffy model. In this study it was found that the fish does not reach a year of age and that the growth rate was typical of that observed in Barbados, further to the south. The data fails to support the two-stock hypothesis in its original formation.
- Keywords: Dolphinfish, *Coryphaena hippurus*, otolith analysis, Puerto Rico, growth, two-stock hypothesis.
- Reference: Copy at NOAA Fisheries Caribbean Field Office

## Marine Reserve

### **42. Hill, R. (1998) Using knowledge of microhabitat selection to maximize recruitment to Marine Fishery Reserves (MFR). Department of Marine Science, University of Puerto Rico- Mayaguez.**

- Marine fishery reserves offer advantages for the management of tropical and temperate fish that can effectively augment conventional management programs. Habitat characteristics have been shown to influence settlement rates and control post-settlement survivorship by affecting growth and predator rates. In this study, newly settled white grunts, *Haemulon plumeri*, are shown to select natural habitats composed of small *Acopora cervicornis* coral heads in a shallow sea grass bed rather than either artificial reefs in the same sea grass bed or natural substrates available in the surrounding areas
- Keywords: Marine fishery reserves, habitat, *Haemulon plumeri*, microhabitat
- Reference: Copy at NOAA Fisheries Caribbean Field Office

### **43. Mateos Molina, D. (2011). Assessing the effects of Mona Island Marine Protected Area on coral reef fishes. University of Puerto Rico, Mayagüez campus.**

- In 2004, a Marine reserve or No-Take Zone (NTZ) NTZ established within the Mona Island Natural Reserve. The objective of this study is to evaluate the effectiveness of the Mona Island NTZ with respect to coral reef fish populations threatened by overfishing. They used a before-after-control-impact (BACI) design to analyze these effects. Fish abundance and biomass of selected species known to be fishery targets

were used as indicators of NTZ effect. Belt transects and roving surveys were used to quantify fish abundances and sizes. Permutational multivariate analyses of variance (PERMANOVA) and SIMPER analysis were carried out to assess spatio-temporal changes between 2005/06 and 2009/10. Significant increases in fish abundance and biomass were observed, suggesting a NTZ effect for important fishery resources.

- Keywords: Mona Island, No-take zone, marine reserve, coral reef fish, fish abundance
- Reference: Oficina de Estudios Graduados (OEG) University of Puerto Rico Mayagüez. <http://grad.uprm.edu/oeg/TesisDisertacionesDigitales/CienciasMarinas/>